

CLAIMS

What is claimed is:

1. A wire apparatus configured for threading through a body passageway to a target location, comprising:
 - a) an elongate wire having a distal end section for delivery to and detachment at the target location, said wire including at least one discontinuity located rearwardly of the distal end section for rupturing when vibrational energy is applied thereto;
 - b) delivery means associated with the elongate wire for delivering therapeutic fluid to the target body location; and
 - c) means for selectively applying vibrational energy to the wire to travel to the discontinuity and cause detachment of the distal end section.
 2. Apparatus as in claim 1, wherein the at least one discontinuity comprises a cut in the wire.
 3. Apparatus as in claim 2, wherein the delivery means comprises a hollow passage formed through the elongate wire to allow therapeutic fluids to flow through the hollow passage and out the distal end section into the target body location.

1 4. Apparatus as in claim 2, wherein the at least one discontinuity further
2 comprises an abrupt mass of material on the hollow wire.

1 5. Apparatus as in claim 4, wherein the abrupt mass is a platinum mass
2 attached with an adhesive.

1 6. Apparatus as in claim 4, wherein the abrupt mass further comprises a
2 plurality of masses.

1 7. Apparatus as in claim 3, wherein the cut does not communicate with the
2 internal hollow of the wire.

1 8. Apparatus as in claim 7, wherein the at least one discontinuity further
2 comprises an abrupt mass of material on the hollow wire.

1 9. Apparatus as in claim 8, wherein the abrupt mass comprises a coil
2 disposed on the outside of the wire.

1 10. Apparatus as in claim 8, wherein the abrupt mass comprises a coil
2 disposed inside the hollow passage of the wire.

1 11. Apparatus as in claim 1, wherein the delivery means for delivering the
2 therapeutic flow is a catheter surrounding the elongate wire, said catheter extending past
3 the at least one discontinuity to the distal end section for delivering therapeutic fluid to
4 the target body location.

1 12. Apparatus as in claim 11, wherein the distal end of the elongate wire is
2 hollow to allow the flow of therapeutic fluid from the catheter through a cut in the wire
3 and out the hollow distal end section into the target body location.

1 13. Apparatus as in claim 11, wherein the at least one discontinuity comprises
2 an abrupt mass of material in the hollow distal end section of wire.

1 14. Apparatus as in claim 13, where the abrupt mass inside the hollow distal
2 end section is further comprised of a platinum mass attached with an adhesive.

1 15. Apparatus as in claim 13, where the abrupt mass inside the hollow distal
2 end section comprises a coil.

1 16. Apparatus as in claim 1, wherein the distal section of the wire is a nickel
2 titanium tube that allows therapeutic fluid to flow through the tube.

1 17. Apparatus as in claim 1, wherein the wire comprises:
2 a) a first section extending from a proximal end to a terminal end;
3 b) a hollow distal end section coupled to the terminal end of the first section by
4 an adhesive; and
5 c) a stainless steel winding soldered to the proximal end of the hollow distal end
6 section and to the terminal end of the first section to provide mechanical interlock for a
7 stronger joint, said distal end section having at least one cut which will allow the passage
8 of therapeutic fluid out of the distal end section into the target body location.

1 18. Apparatus as in claim 1, wherein the vibrational energy applying means is
2 selected from the group comprising an ultrasound generator coupleable to the proximal
3 end of the wire, and a striking hammer coupled to the proximal end of the wire.

1 19. Apparatus as in claim 1, wherein the vibrational energy applying means
2 applies vibrational energy selected from the group comprising axial and torsional
3 vibrations.

1 20. Apparatus as in claim 1, wherein the vibrational energy applying means is
2 selectively adjustable to apply energy at a frequency and magnitude selected to cause
3 detachment of the wire at a selected one of the at least one discontinuities.

1 21. A wire apparatus with a detachable distal end, comprising:

2 a) an elongate wire, including a hollow distal end section for delivery to and
3 detachment at a target body location, said wire including at least one discontinuity
4 located proximally of the distal end section for rupturing when vibrational energy is
5 applied thereto, said discontinuity further comprising:

6 1) a terminal end of the elongate wire inserted inside the hollow distal end
7 section;

8 2) a metal winding wrapped around the terminal end of the wire and
9 soldered to the terminal end;

10 3) an adhesive joint binding the wire and the end section, such that the
11 metal winding strengthens the adhesive joint; and

12 4) at least one cut in the hollow tube to allow the passage of a therapeutic
13 fluid through the distal end section;

14 b) a catheter surrounding the elongate wire and extending past the discontinuity
15 in the distal end section for delivering therapeutic fluid to the target body location; and

16 c) means for selectively applying vibrational energy to the wire to travel to the
17 discontinuity and cause detachment of the distal end section.

1 22. Apparatus as in claim 21, further comprising a platinum mass disposed
2 within the hollow distal end section, and disposed to allow therapeutic fluid to flow

3 through the distal end section and the at least one cut, wherein the cut aids in detaching
4 the distal end.

1 23. Apparatus as in claim 21, wherein said at least one cut is deep enough to
2 allow therapeutic fluid to flow through the cut.

1 24. Apparatus as in claim 21, wherein said at least one cut is wide enough to
2 allow therapeutic fluid to flow through the cut.

1 25. Apparatus as in claim 21, wherein the wire is constructed of stainless steel,
2 and wherein said distal end section is constructed of nickel titanium alloy.

1 26. Apparatus as in claim 21, wherein said at least one cut is cut to a depth to
2 readily cause rupturing of the distal end section at the location of the at least one cut
when the vibrational energy is applied thereto.

1 27. Apparatus as in claim 21, wherein the vibrational energy applying means
2 comprises an ultrasound generator coupleable to the proximal end of the wire.

1 28. Apparatus as in claim 21, wherein the means for selectively applying
2 vibrational energy to the wire is selected from the group comprising means for selectively
3 applying axial and torsional vibrations to the wire.

1 29. A method of disposition of an occlusive element and delivering a
2 therapeutic fluid to a target location in a vasculature passageway comprising:
3 a) threading an elongate wire contained inside a catheter into a vasculature
4 passageway so that a hollow distal end, forming an occlusive element, is disposed at the
5 target location, said distal end being detachable from the wire when an ultrasound signal
6 is applied to the wire;
7 b) delivering a therapeutic fluid from the catheter through a wide cut in the
8 hollow distal end to the target location inside the vascular passageway;
9 c) applying an ultrasound signal to the wire to cause the distal end thereof to
10 detach at the target location; and
11 d) withdrawing the wire from the vasculature passageway, leaving the distal end
12 at the target location.

1 30. The method of claim 29 wherein the step of threading the elongate wire
2 further comprises threading a hollow wire having at least one cut, into the vasculature
3 passageway so that the distal end, forming an occlusive element, is detached from the
4 wire when an ultrasound signal is applied to the wire.

1 31. The method of claim 29, wherein the step of applying an ultrasound signal
2 to the wire to cause the distal end thereof to detach at the target location further
3 comprises:

- 4 e) producing an electrical signal having a periodic waveform of a selected
5 frequency;
6 f) converting the electrical signal into mechanical vibration of the wire by means
7 of a transducer disposed at a proximal end of the wire;
8 g) measuring the impedance and frequency of the electrical signal due to
vibration of the wire;
10 h) monitoring the change in impedance to determine when the detachable end
section of the wire has detached; and
12 i) generating a humanly discernable signal for indicating to a user when
detachment has occurred.

1 32. A system for determining when detachment of a detachable distal end
2 section of a wire device has occurred, comprising:

- 3 a) means for converting electrical signals into mechanical vibration of the wire
4 device;
5 b) means for producing a periodic waveform of a selected frequency;

6 c) means for amplifying the periodic waveform and delivering the waveform to
7 the means for converting electrical signals into mechanical vibration;
8 d) means for measuring the impedance of the means for converting electrical
9 signals into mechanical vibration; and
10 e) means for monitoring the change in impedance of the means for converting
11 electrical signals into mechanical vibration to determine when the detachable distal end
12 section of the wire device has detached, and generating a humanly discernable signal for
13 indicating to a user when detachment has occurred.

33. The system as in claim 32, further comprising:
1 a) a transducer connected to a proximal end of the wire device for converting the
2 electrical signals into mechanical vibration of the wire device;
3 b) a frequency generator for producing the periodic waveform;
4 c) a power amplifier for amplifying the periodic waveform produced by the
5 frequency generator and delivering the waveform to the transducer;
6 d) a spectrum analyzer for measuring the impedance of the transducer and for
7 generating a plot of impedance versus frequency of the waveform exhibiting resonant
8 peaks due to the physical characteristics of the wire device; and
9 e) means for displaying the plot of impedance versus frequency of the waveform
10 in a humanly discernable form, whereby a user may detect when the detachable distal end

12 section of the wire device has detached by discerning changes in the resonant peaks of the
13 plot.

1 34. The system as in claim 33, wherein the spectrum analyzer measures the
2 impedance of the transducer by detecting the frequency, voltage, and electrical current
3 input to the transducer.

1 35. The system as in claim 33, wherein the means for displaying the plot of
2 impedance versus frequency of the waveform comprises a CRT display screen.

3 36. The system as in claim 33, further comprising second means for
generating a humanly discernable signal for indicating when detachment has occurred.

3 37. The system as in claim 36, wherein the second means for generating a
humanly discernable signal for indicating when detachment has occurred is selected from
the group comprising an indicator lamp, an audible alarm, and a CRT display indication.

1 38. A method for determining when detachment of a detachable end section of
2 a wire device has occurred, comprising the steps of:

3 a) producing an electrical signal having a periodic waveform of a selected
4 frequency;

- 5 b) converting the electrical signal into mechanical vibration of a wire device
- 6 having a detachable end section;
- 7 c) measuring the impedance and frequency of the electrical signal due to
- 8 vibration of the wire device;
- 9 d) monitoring the change in impedance to determine when the detachable end
- 10 section of the wire device has detached; and
- 11 e) generating a humanly discernable signal for indicating to a user when
- 12 detachment has occurred.